CARDIAC DECONDITIONING DURING PROLONGED HYPODYNAMIA

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Translation of "Detrenirovannost' serdtsa pre dlitel'noy gipodinamii," Voyenno-Meditsinskiy Zhurnal, No. 12, December 1973, pp. 54-56

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16. Abstract The influence of 30-day hypodynamia on heart size, stroke volume and myocardial contractility was the objective of these experiments. The subjects were 20 healthy male volunteers divided into 3 groups. Members of the first group stayed in bed during the whole experiment, the men of the second group were free to move in a small chamber, and members of the third group stayed in bed and performed daily intensified physical exercises. Teleroentgenokymograms were used to determine the heart size (systolic and diastolic) and the stroke volume. The data obtained (tabulated) indicate that by the end of the experiment, the heart size of the men in the first group was reduced by about 20% and stayed at this level during the next month. The men also complained of dyspnea and tachycardia during physical loading, particularly during the first 10 days after the experiment. A similar reduction (about 10%) was experience by the test subjects of the second group, while in the third group these changes were insignificant. Complete restoration of heart size and stroke volume required 60 days. Daily exercises (the third group) almost fully prevented the development of cardiac deconditioning.

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A study was made of the influence of 30-day hypodynamia of /54* various degrees on heart size, stroke volume and myocardial contractility. Twenty healthy, physically fit male volunteers took part in the experiments. Their ages were from 21 to 35. In all, three series of experiments were conducted. In the first series, the examinees (six men) stayed in bed for the whole of the experiment; in the second (seven), they were free to move in a small chamber; in the third (seven) they stayed in bed but carried out strenuous physical exercises each day.

Heart size and stroke volume were determined by teleroentgenokymograms. By using the Shick formula, they calculated the amount of systole and diastole on the area of the heart shadow, and also determined the stroke volume. According to observations carried out by I. Ya. Shick (1940), I. L. Arobey (1959), Gayton (1969), indicators, very close to the true ones, can be obtained by this method. Keys (1941) determined that the difference between the results of the acetylene and roentgenokymographic methods for determining the systolic volume is only ±5%. The results we obtained are shown in the table.

From the table it can be seen that towards the end of the experiment, the heart size of those taking part in the first series was reduced on an average in the systole period by 19.4% and in the diastole period by 20.2%. This indicator was maintained on approximately the same level for a month after returning to normal life. During all this time, especially during the first 10 days after the /55 experiment had finished, the examinees complained of dyspnea and

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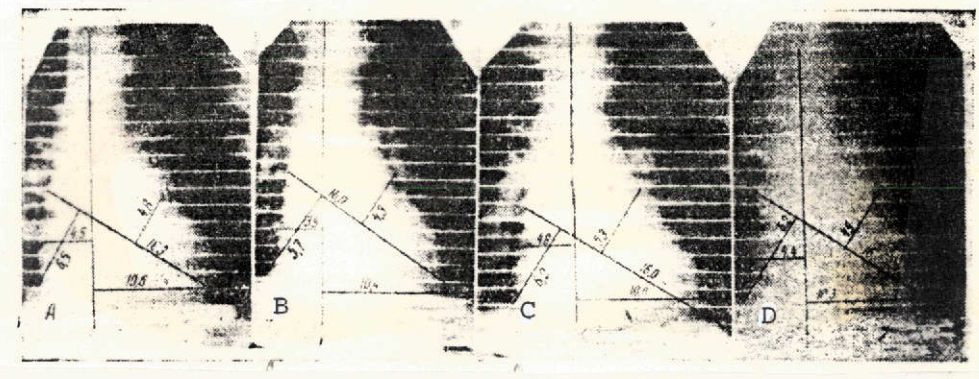
* Numbers in the margin indicate pagination in the foreign text.

Series of experiments	Number of examinees	Heartcapacity in cm^3								Stroke volume in ml			
		Before experiment		Immediately after experiment		After 1 month		After 2 months		Before experiment	Immediately after experiment	After 1 month	After 2 months
		Systole	Diastole	Systole	Diastole	Systole	Diastole	Systole	Diastole				
1	6	781.5 ± 44.4	880.2 ± 33.5	630 ± 37	702 ± 52.8	623.2 ± 30.6	711.5 ± 46.2	789.4 ± 56	899 ± 61	49.8 ± 3.6	36 ± 4.4	44.2 ± 3.1	54.8 ± 6.3
2	7	627.6 ± 29.9	732.6 ± 32	566.5 ± 43.7	657 ± 57.2	645.8 ± 36.6	745.9 ± 38.3	—	—	52.5 ± 3.6	46.8 ± 5.1	50.2 ± 2.5	—
3	7	754.8 ± 56.2	870.9 ± 56.7	725.9 ± 48.2	836.3 ± 48	754.8 ± 57	874.8 ± 54.5	—	—	58.2 ± 2.9	55.2 ± 3.4	62.8 ± 4.2	—

tachycardia during physical loading and also pain in the joints and muscles of the lower extremities. The heart was restored to its normal size towards the end of the second month (see figure). The stroke volume was also noticeably reduced; at the end of the experiment it was lower than the initial one by almost one-third (by 27.7%). A month later, recovery began, but it fell short of its initial level by 11.3%. After 2 months, the stroke volume was slightly above the initial one.



Teleroentgenokymograms of examinee I's heart: A - before the experiment (heart size in systole 753.8 cm^3, in diastole 846.4 cm^3; stroke volume 46.3 ml); B - directly after the experiment (s (583.2 and 647 cm^3, 32 ml); C - after 1 month (629.2 and 697.4 cm^3, 34.1 ml); D - after 2 months (754 and 850.2 cm^3, 48.1 ml).

The heart size during systole and diastole and also the stroke volume of examinees taking part in the second series of experiments was reduced by approximately 10% towards the end of 30 days. Myocardial contractility also underwent change, but to a lesser degree than in those taking part in the first series. In this case, recovery continued for a month after the experiment had finished. In the third series, changes in heart size and stroke volume of the examinees were insignificant. The myocardial contractility scarcely changed.

The results we obtained show that there is a need for a person to keep physically active to restore the cardiovascular system to normal. The complete absence of muscular activity for 30 days causes cardiac deconditioning, a radiology picture of which has the following characteristics: a reduction in shadow size, smoothness of lateral contours ("drop heart"), shallow and increased pulsation. A change in myocardial contractility could be seen on roentgenokymograms (small, acuminate teeth).

The most characteristic reaction of a deconditioned heart is physical loading. If before hypodynamia, the stroke volume of all examinees after loading increased together with heart contractions, after hypodynamia, the pulse increased. The stroke volume either did not change at all or changed insignificantly, in some cases, it even decreased. Cardiac deconditioning took place not only when there was complete inactivity, but when there was relatively restricted movement, although to a lesser degree (second series), /56
that is, in conditions approximating professional activity of some groups of servicemen.

The restoration of normal heart functions to the initial level took place very slowly. Sixty days were required for the heart size and stroke volume to return to normal. After being in a small chamber, the restoration period was equal to the time spent in it. Strenuous daily exercises (third series) almost completely prevented the development of cardiac deconditioning.

What has been said above underlines the importance for keeping servicemen in good physical condition. It is especially necessary among those whose professions require only limited physical exercise.